The $\vec{n} + p \rightarrow D + \gamma$

PROJECT MANAGEMENT PLAN

FOR

EXPERIMENT AND BEAM LINE CONSTRUCTION

November 28, ~~August 14,~~ 2001
~~28 May 2001~~

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APPROVALS

This Management Plan provides the baselines and controls that the $\vec{n} + p \rightarrow D + \gamma$ (NPDGamma) collaboration, the NPDGamma management and the Los Alamos National Laboratory Management will follow to meet the technical, cost, and schedule goals for the NPDGamma experiment in flight path 12 (FP-12) at the Los Alamos Neutron Science Center (LANSCE). This plan will be reviewed and updated as required in consultation with the funding agencies and Los Alamos National Laboratory.

David Bowman NPDGamma Spokesperson LANL	Date	Kevin Coulter UM NPDGamma Executive Committee	Date
Seppo Penttila NPDGamma Project Manager LANL	Date	Mark Leuschner UNH NPDGamma Executive Committee	Date
Susan Seestrom P-Division Leader LANL	Date	Shelley Page U. of Manitoba NPDGamma Executive Committee	Date
John McClelland Nuclear Physics Program Manager LANL	Date	Mike Snow IU NPDGamma Executive Committee	Date
Mary Hockaday P-23 Group Leader LANL	Date	Paul Lisowski LANSCE Division Leader LANL	Date
Alan J. Hurd Lujan Center Director LANL	Date		

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Project Management Plan Update/Revision Procedure

The Project Manager has the lead responsibility for initiating and coordinating reviews and updates to this Project Management Plan (PMP). Reviews and updates to the PMP must be coordinated with the organizations signing the PMP, including the following organizations:

- LANL P-Division
- LANL NPP Program Manager
- P-23 Group Leader
- LANSCE Division
- Executive Board of the NPDGamma Collaboration
- NPDGamma Collaboration

Revisions and updates to this PMP are classified into three categories:

1. Minor Administrative Changes: Minor changes such as administrative, organizational, grammatical errors, etc., identified through annual reviews or identified by any member of the collaboration and brought to the attention of the Project Manager. Minor corrections, revisions, etc., will be incorporated into the appropriate PMP sections by the Project Manager utilizing a redline/strikeout method. Deleted text will be highlighted with a strike out, and added text will be indicated utilizing the redline function. The effective pages of the PMP will then be transmitted to the respective members and organizations for review. Upon closure of the review process, the changes will be incorporated in the text of the PMP, and new pages with an alpha character suffix added to the original page number will be generated. (as an example page 15 will be changed to 15-A). The revised PMP pages will be annotated with a footer indicating the Revision No. and date of the revision. A summary of the PMP revisions and changes will be also documented in the PMP Change Log located on page ix of this document. The Project Manager is responsible of the distribution of the final PMP changes. The Project Manager is responsible for maintaining a complete history of the PMP and changes or modifications, to include reviews and review comments.

2. Project Baseline Changes: For changes to the project associated with or driven by the Baseline Change Control Procedures, the affected portions of the PMP will be modified for the proposed changes in accordance with paragraph 1 above. The appropriate changes to the PMP will be incorporated as required to reflect any changes to the project and revised PMP pages will be issued to all project members and organizations that maintain copies of the PMP.

3. Major Changes: Major changes to the PMP will be processed in the same manner as described above with the exception that in such cases, the Spokesperson of the collaboration will initiate a completely revised PMP for the review process. For major revisions, the revised PMP will be handled as a new PMP.

The review process for the updates/revisions to this PMP may be completed either through normal hard-copy/mail distribution or electrically via computer.

Project Management Plan Change Log

Revision Number	Date	Description	Pages Changed
1.0	13 March-2001	Baseline – given to DOE	
1.1		Addition to Acronyms & Abbreviations	x
1.1		Updated Figure 2.2	4
1.1		Updated Table 3.3 and 3.4	12
1.1		Redone Table 3.6	13
1.1		Dates for Milestones in Table 3.7 and 3.8	13,14,15,16
1.1		Fixed WBS numbering in Table 4.1	17
1.1		Correct spelling and correct LANL and DOE numbers	21
1.1		Correct column title Table 6.5 and 6.6	23 and 24
1.1		Appendix C – added text to WBS dictionary	C1-C7

Acronyms & Abbreviations

DOE .... U. S. Department Of Energy
FP .... Flight Path
FY .... Fiscal Year
IUCF .... Indiana University Cyclotron Facility
LANL .... Los Alamos National Laboratory
LANSCE .... Los Alamos Neutron Science Center
NSF .... National Science Foundation
NIST.......................... National Institute of Standards
NPDGamma .... neutron+proton → deuteron+gamma ray
NPP .... Nuclear Physics Program
PMP........................... Project Management Plan (this document)
QA............................. quality assurance
UM .... University of Michigan
UNH.......................... University of New Hampshire
WBS.......................... Work Breakdown Structure
WP .... Work Package

1 INTRODUCTION TO THE NPDGAMMA PROJECT

The NPDGamma collaboration was formed and the proposal for the experiment written in 1997. The primary physics goal of the experiment is to measure the parity-violating asymmetry of the direction of gamma emission with respect to the neutron spin when polarized neutrons are captured in parahydrogen. The physics of the NPDGamma experiment was reviewed in 1997 by the Pendlebury Committee. In 1998 a technical review of the project was performed by the Spinka I Committee. The result of this review created the cost baseline and schedule baseline for the project.

After the Spinka I Committee validations, the baseline budget and the schedule were presented to DOE. The NPDGamma project (consisting of the construction of the experiment and the beam line) was seeking $2,537k capital funding from DOE. The scheduled completion date included in the validated baseline was November 2001. In 1999 the project received its first DOE capital funds.

Following the Spinka I Committee, the project was separated into two projects; the construction of the NPDGamma experiment and the beam line construction. The estimated cost of the beam line was affected by changes at LANSCE. These included the LANSCE spallation neutron source becoming a Category III (CAT III) nuclear facility, the facility tightening its radiological shielding requirements, and the length of the beam line increasing to gain adequate floor space for the experiment. These changes increased the cost estimate of the beam line significantly. This elevated cost estimate triggered a new technical review - the Spinka II Committee that took place in September 2000. The Spinka II review recommended that the NPDGamma project develop a written Project Plan and develop an improved cost estimate based on standard contingency rates.

After the Spinka II review the NPDGamma collaboration initiated preparation of the Project Management Plan (PMP) as well as the validation of the cost and the schedule for the construction of the experiment and the beam line. The PMP includes the new cost and schedule baselines for the construction of the NPDGamma experiment and the beam line construction.

In addition, the PMP documents the plan, means, methods, and controls that will be used to achieve the project objectives. The goal of this PMP is to ensure that the NPDGamma has:

- formal management in place
- reliable cost, schedule and contingency
- management control in place
- appropriate reporting in place

and that the NPDGamma meets:

- its design specifications and
- relevant Laboratory's ES&H requirements
- relevant Laboratory's Quality Assurance requirements.

The PMP is a living document that will be updated as required and reviewed at least annually until the project is completed. In addition to the INTRODUCTION, this document contains the following:

- Experiment Overview
  Includes a description of the experiment and its physics justification and describes the beam line construction project.
- Management Information
  Includes information on organizational structure, roles, responsibilities, collaboration, cost and schedule baseline, contingencies, and work breakdown structure.
- Work Plan
  Includes descriptions of the experiment and beam line work packages for construction.
- Management of the Project
  Summarizes the management control, technical control, cost and schedule control, performance control, contingency control, and progress reporting.
- Cost, Schedule, and Resources
  Summarizes cost estimates, contingency estimates, and gives necessary budget and schedule tables.

2 OVERVIEW OF THE NPDGAMMA PROJECT

2.1 Physics of the NPDGamma Experiment

The NPDGamma experiment will measure the parity-violating gamma ray asymmetry with respect to the neutron spin when polarized cold neutrons are captured by para-hydrogen. The asymmetry is expected to be very small, ~5×10^{-8}. With the LANSCE spallation source it is possible to measure this asymmetry to an accuracy of 10% assuming that the experiment is carefully designed and built. The experiment will use the pulse structure of the beam to control systematic errors. The experimental setup is shown in Fig. 2.1.

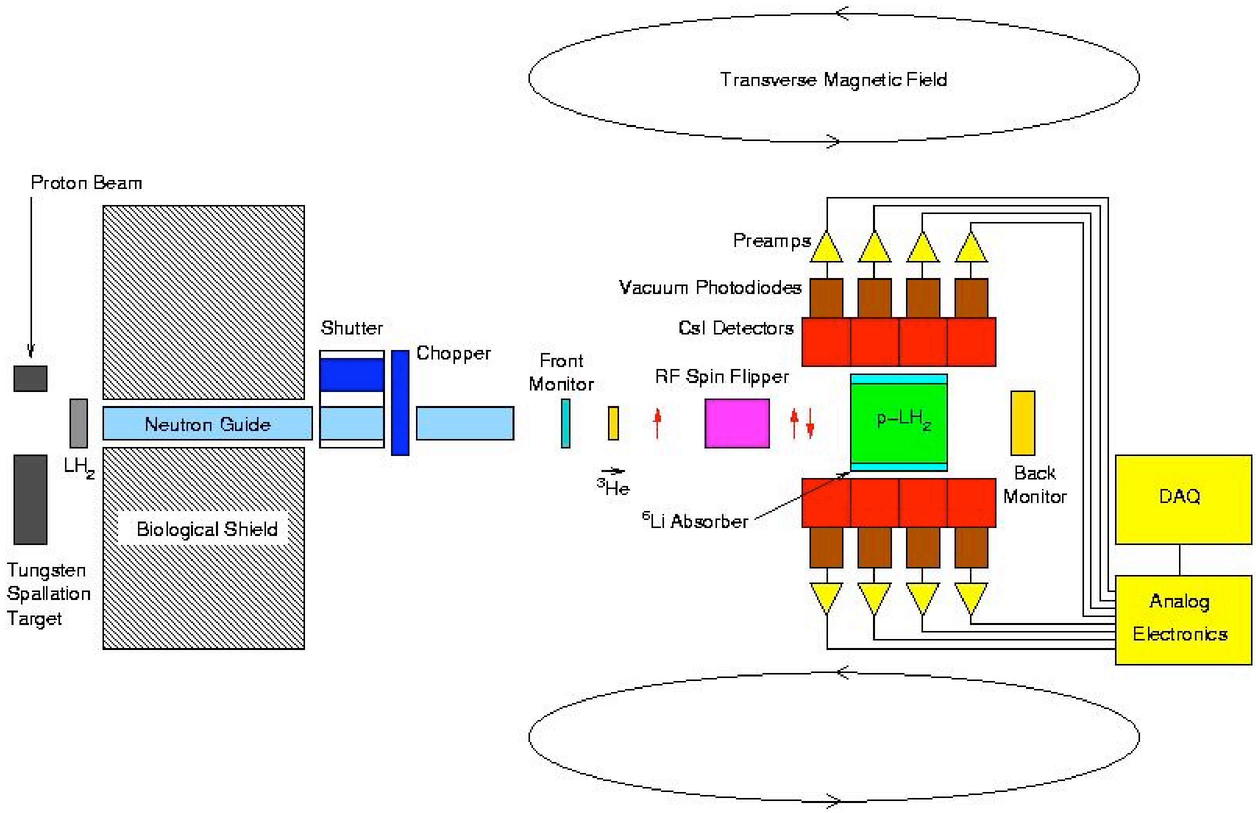

Figure 2.1 Experimental setup of the NPDGamma experiment.

The detailed description of the NPDGamma experiment and the beam line can be found in the proposal "Measurement of the Parity-Violating Gamma Asymmetry A_γ in the Capture of Polarized Cold Neutrons by Para-Hydrogen, $\vec{n} + p \rightarrow d + \gamma$." The proposal is available at the home page of the NPDGamma Collaboration: http://p23.lanl.gov/len/npdg/.

2.2 Integrated Beam Line Construction

The NPDGamma experiment will be constructed on flight path 12 at the Manuel Lujan Jr. Neutron Scattering Center (MLNSC) at LANSCE. In addition to the construction of the experiment, the NPDGamma collaboration has to build the beam line for the experiment, since the original flight path 12 includes only a hole in the bulk shield viewing a new upper tier cold moderator of the spallation source. The beamline will include the neutron guide from the moderator to the experiment, the external shutter and frame definition chopper, and the radiological shielding around the beamline. Simultaneously with the flight path 12 construction work, two other flight paths will be built by LANSCE Division - flight paths 11A and 13. The construction of these beamlines will be a collaborative effort between Physics and LANSCE Divisions coordinated by LANSCE. This integrated construction plan was one of the recommendations of the Spinka I Committee. Figure 2.2 shows a cutaway view of the FP12 and 13 integrated shielding in ER1 viewed towards the source. The narrow blue blocks after the bulk shield are the shutters followed by the neutron guides. On the right is FP 11 and its shutter box.

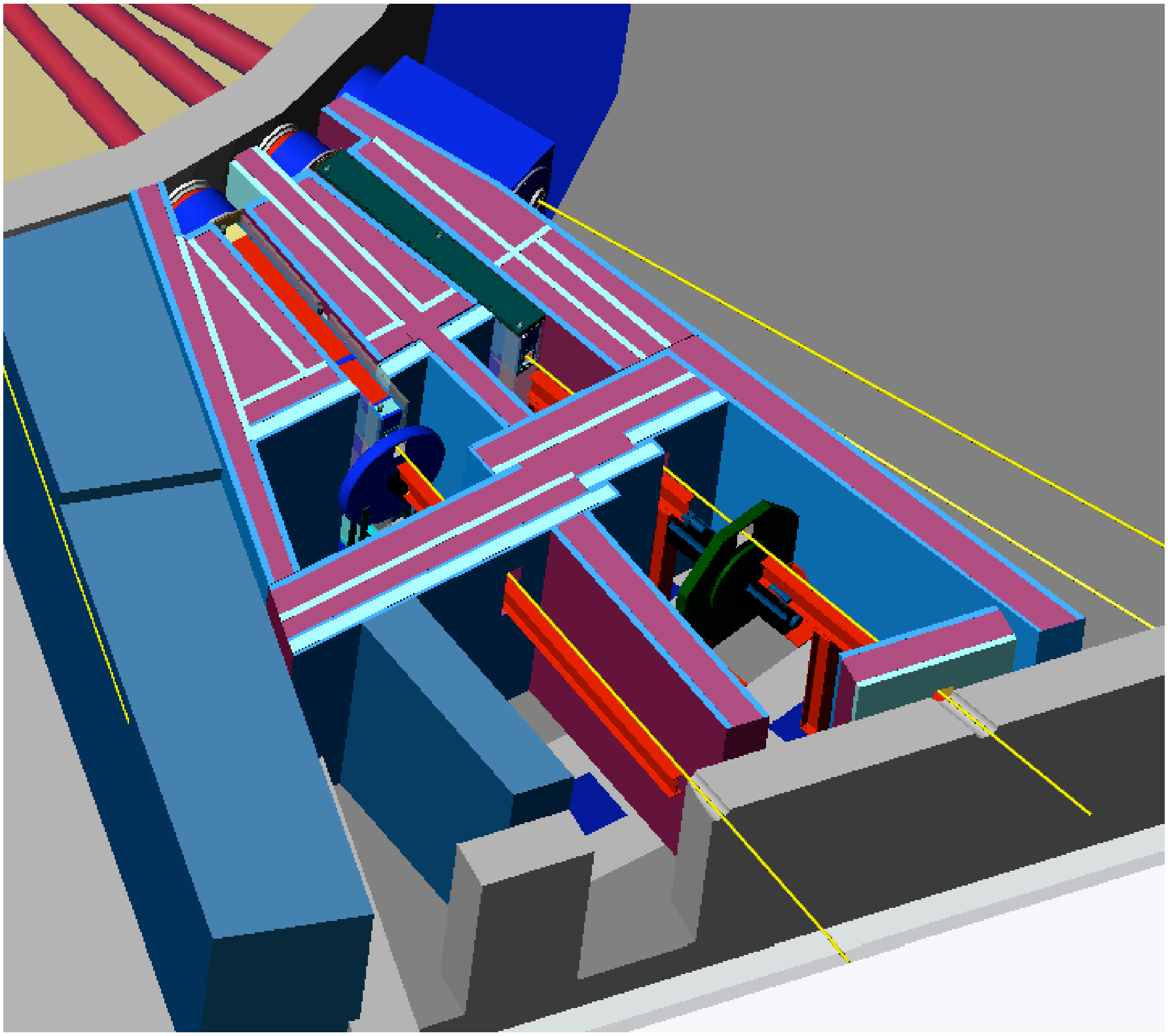

Figure 2.2 Cutaway view of the FP12 and 13 integrated shielding in ER1 viewed towards the source. From left to right are FP13, FP12, and FP11. The dark red is the laminated iron-polyethylene shielding, blue boxes next to the bulk shield are the shutters and orange lines are the neutron guides.

3 MANAGEMENT INFORMATION

The NPDGamma PMP is concerned with the design, construction, installation, testing, and commissioning of the experiment and the beamline. This PMP outlines the management structure and responsibilities for tracking budget, schedule and performance. Those responsibilities will begin upon approval of the PMP and they will end as soon as the NPDGamma experiment and beamline have been commissioned.

3.1 Management Organization

The management organization specifies responsibilities for getting the experiment and beamline hardware designed, built, installed, and commissioned. Special attention will be given to the quality and integration of components of the experiment. The Spokesperson (J. D. Bowman, LANL) with assistance of the Project Manager (S. Penttila, LANL) and the management team (Bowman, Penttila, and S. Wilburn, LANL) have overall responsibility for execution of the design, construction, installation, and commissioning of the experiment and the beamline including cost, schedule and performance controls. In his role, the Spokesperson reports directly to the P-23 Group Leader and the LANL Nuclear Physics Program (NPP) manager. The Spokesperson also has the responsibility of coordinating the work of the collaboration and responding to technical and scientific initiatives from the collaboration. The organizational chart for the collaboration is shown in Figure 3.1~~Figure 3.1~~~~Figure 3.1~~. The organizational chart for the construction phase of the experiment and beamline is shown in Figure 3.2.

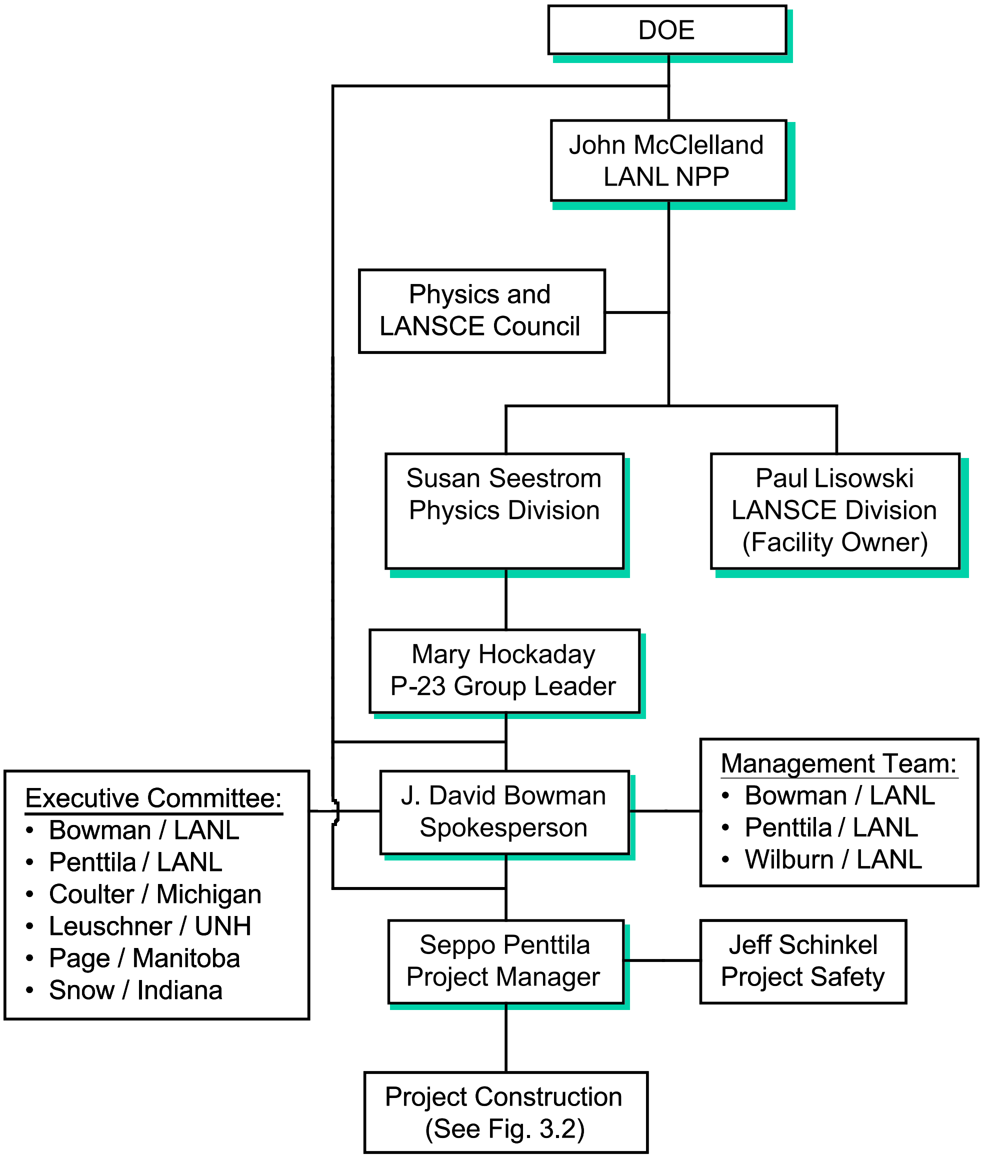

Figure 3.1 Organizational chart of the NPDGamma project management structure.

3.1.1 ORGANIZATIONAL CHART

The organizational chart depicted in Figure 3.1~~Figure 3.1~~~~Figure 3.1~~ illustrates the division of responsibilities, lines of communication and reporting route in the NPDGamma projects. The job description and responsibilities assigned to these people will be described in the following sections.

The Program Manager for the Facilities and Instrumentation of Division of Nuclear Physics in the U.S. Department of Energy shall have a direct line of communication with the Spokesperson and Project Manager on issues of scope, cost, schedule, and collaboration. The Spokesperson and Project Manager will provide information on any of these issues at the request of the DOE Program Manager for Facilities and Instrumentation. Formal quarterly reporting on costs, schedule, and milestones will be from the projects to the LANL line management and to the LANL program management as shown in the organizational chart. The purpose of having a unique chain of formal reporting is to avoid any ambiguity in responsibilities for reporting to DOE.

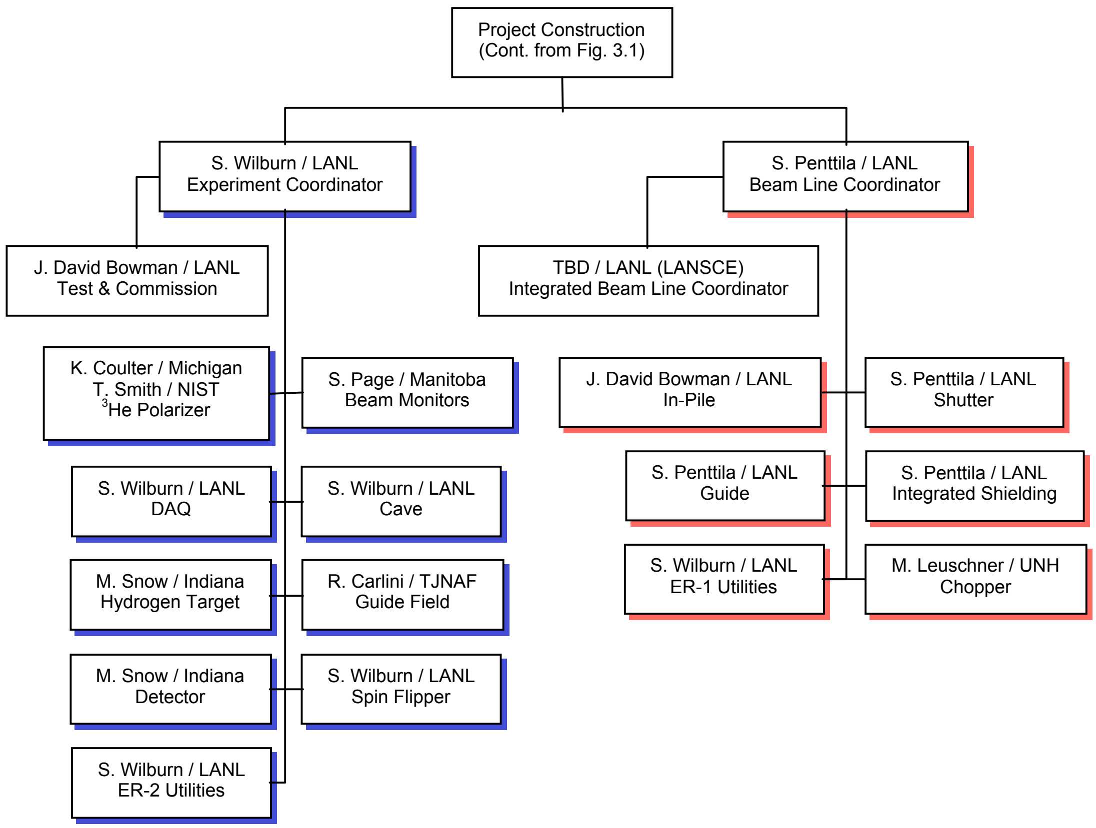

Figure 3.2 Organizational chart for management of the construction of the experiment and beamline.

3.1.2 SPOKESPERSON

The Spokesperson has the overall responsibility for planning and execution of the project. This includes oversight of the physics program and its scope, overall coordination of the project, as well as overall management of the collaboration. The Spokesperson has specific responsibilities for approval of Class 2 or greater change requests (see Table 3.1). The spokesperson will act on behalf of the collaboration in interactions with LANL management and with the funding agencies. The Spokesperson is chair of the Executive Committee. The Spokesperson will refer issues significantly affecting the NPDGamma project such as changes in cost, schedule, or scope to the P-23 Group Leader and the NPP manager.

3.1.3 EXECUTIVE COMMITTEE

The Executive Committee assists the Spokesperson to manage the project. The Executive Committee is formed by the Spokesperson, the Project Manager, and four representatives of the collaboration representing the broad interests of the collaboration. Decisions of the Executive Committee are subject to review by the collaboration. In this PMP, the collaboration meeting is the highest authority in the collaboration. The membership of the Executive Committee will be selected by the collaboration and may be changed in subsequent collaboration meetings. The elected members of the Executive Committee, with the exception of the Spokesperson and Project Manager, will serve for a maximum two-year term. Meetings of the Executive Committee can be called by any of its members. The Executive Committee has specific responsibilities regarding the approval of Class 3 and Class 4 change requests including changes in cost, schedule, or performance, as outlined in this Section. The other functions of the Committee will be to serve as the stewards of the experiment, consult regularly with each other and with the collaboration to facilitate communications and monitor the overall status of the project, and make decisions on issues affecting the construction of the beamline and experiment. In addition to its formal responsibility, defined in this PMP, the Executive Committee should monitor the budget, schedule, and performance of the beam line construction and experiment and in doing so assist in keeping the project on track. The Executive Committee represents the collaboration in an advocacy role to funding agencies, LANSCE, and Physics Divisions, and in other situations.

3.1.4 PROJECT MANAGER

The Project Manager is responsible for the overall management of the project. He is responsible to the Spokesperson to deliver all necessary equipment on schedule and within the budget guidelines defined in this document. He shall establish the budgets and schedules for the construction of the experiment and the beamline based on the information provided by the Work Package Leaders. The Project Manager is responsible for tracking the progress of the project - cost and schedule - and reporting as outlined in Section 5. He shall formulate the guidelines for making changes to either budget and schedule or performance, including clear rules for handling of contingency funds (see Section 5.6). He will give progress reports at meetings of the Executive Committee and at collaboration meetings. Also, written NPDGamma monthly Progress Reports as described in Section 5.7 will be sent to the P-23 Group Leader, NPP manager, and members of the Executive Committee. For the Work Package Leaders and collaboration, the monthly reports will be posted to the NPDGamma home page.

3.1.5 MANAGEMENT TEAM

The Project Management Team (Spokesperson, Project Manager, Experiment Coordinator, and Beamline Coordinator) assists the Spokesperson to deliver all necessary equipment on schedule and within the budget guidelines defined in this document. The Team's responsibility is to assure that all subsystems are designed, fabricated, and installed in a coherent manner. This will require working with Work Package Leaders to arrive at mutually acceptable interface specifications. The Management Team is also responsible for assuring that no items or tasks are overlooked, and that all necessary components are included in the overall budget and schedule planning. If resolution of interface issues requires changes to the scope, budget, or schedule of a subsystem, it will be handled according to the rules outlined in the change request classification table, Table 3.1.

Table 3.1 Change request classification for the NPDGamma project. Guidelines for changes in cost, schedule and/or performance with their respective approval levels.

Class	Change in			Approval
	Cost	Schedule	Performance	
1	Minor, within WBS line item (<$2k or 1%)	"float"	No impact	Project Manager
2	Within Work Package contingency , (>$5k or 1%)	< 1 quarter delay of milestone	Change in a part of Work Package but does not affect Work Package performance or scope	Above, plus Spokesperson
3	Within overall NPDG contingency (>20k or 10%)	> 1 quarter delay of milestone	Change affects Work Package performance but does not effect NPDG performance	Above, plus Executive Committee and NPP Program Manager
4		> 1 quarter delay of major project milestone	Technical scope change, affects project capability	Above, plus DOE

3.1.6 PROJECT SAFETY

The Project Safety person is responsible to the Project Manager for ensuring that all environment, health and safety aspects are anticipated and fully addressed.

3.1.7 EXPERIMENT COORDINATOR

The Experiment Coordinator has the responsibility for oversight of all performance assessment aspects of individual subsystems of the experiment. He is responsible for coordinating and integrating the efforts between the subsystems.

3.1.8 WORK PACKAGE LEADER

Work of the NPDGamma project is contained in Work Packages managed by Work Package Leaders. A Work Package Leader is responsible to lead and oversee the specifications, design, maintenance and operation of his Work Package (See Section 5).

The definition of all specifications and design parameters for a Work Package is given in the Work Package Dictionary in Appendix E. The Work Package Leader serves as an information resource for the Project Manager by providing advice and additional information as needed. The Work Package Leader is responsible to report monthly on the status and progress of his/her Work Package to the Project Manager.

3.2 Beam Line Construction Organization

Simultaneously with flight path 12 construction work, the LANSCE Division is constructing a new beamline 13 and modifying the existing flight path 11A. To optimize resources, a decision was made, according to a Spinka I recommendation, to build the ER-1 part of these flight paths as an integrated effort. Because the LANSCE Division owns the facility, it was natural that they are responsible for coordinating the integrated beamline construction. The co-operative construction effort is outlined in the Memorandum-of-Understanding between the Physics and LANSCE Divisions. This MOU is available at http://p23.lanl.gov/len/npdg/.

3.2.1 BEAMLINE COORDINATOR

The Beamline Coordinator has the responsibility for oversight of the design, construction and performance of the beamline components. He is responsible to lead, coordinate and integrate the construction efforts, and to communicate with other beamline responsible project managers. The Beamline Coordinator is responsible to report to the Project Manager.

3.2.2 INTEGRATED BEAMLINE COORDINATOR

The Integrated Beamline Coordinator (LANSCE) (TBD) is responsible for managing the integrated beam line construction work. His responsibility is to work with the flight path 12 Beamline Coordinator and other beam line responsible project managers to coordinate work and report to the LANSCE management.

3.3 The NPDGamma Collaboration

Table 3.2 Members of the NPDGamma collaboration, "Measurement of the Parity-Violating Gamma Asymmetry A_ in the Capture of Polarized Cold Neutron by Para-Hydrogen, $\vec{n} + p \rightarrow D + \gamma$." The active member list can be seen at http://p23.lanl.gov/len/npdg/.

Institution	Collaborators
Los Alamos National Laboratory	J. D. Bowman (Spokesperson), G. L. Greene, G. S. Mitchell, G. L. Morgan, S. I. Penttila, W. S. Wilburn, and V. W. Yuan
Indiana University	C. S. Blessinger, M. Gericke, H. Nann, and W. M. Snow
University of Michigan	T. E. Chupp, K. P. Coulter, R. C. Welsh, and J. Zerger
National Institute of Standards and Technology	M. S. Dewey, T. R. Gentile, and F. E. Wietfeldt, T. B. Smith, D. R. Rich
Thomas Jefferson Nat. Accelerator Facility	R. Carlini
University of California, Berkeley	T. Case, -S. J. Freedman and B. K. Fujikawa
KEK National Laboratory, Japan	S. Ishimoto, Y. Masuda, and K. Morimoto
Hamilton College	G. L. Jones
University of New Hampshire	M. B. Leuschner, B. Hersman
University of Manitoba and TRIUMF	S. A. Page and W. D. Ramsay
Joint Institute for Nuclear Research, Dubna, Russia	E. I. Sharapov

3.4 Memoranda-of-Understanding

The Los Alamos National Laboratory's Physics Division has entered into formal agreements (Memoranda-of-Understanding, or MOUs) with the universities and laboratories in the NPDGamma collaboration. These MOUs outline the activities that members of each group are carrying out in collaboration with LANL Physics Division, and their responsibilities, funding and scheduling plans. The MOUs are signed by the relevant manager in the institute, to state formally that the institute will support the efforts of their group's duties as outlined in the MOU. Although not legally binding in the strictest sense, these MOUs are the formal method to guide the collaboration between LANL Physics Division and outside collaborators.

The MOU between Physics Division and LANSCE Division outlines the use of the beam line and how costs of the integrated beamline construction will be shared. This MOU is available at http://p23.lanl.gov/len/npdg/.

An example MOU between Physics Division and the University of New Hampshire is included in Appendix C.

Table 3.3 Memoranda of Understanding.

Institution	PI	WBS	Status
Hamilton Collage	G. Jones	1.4	Signed
IU	M. Snow	1.3	Signed
IU	M. Snow	1.7	Signed
KEK	Y. Masuda	1.3	Signed~~In Progress~~
U. of Manitoba	S. Page	1.3 & 1.8	Signed
UM	T. Chupp	1.4	In Progress
UNH	W. Hersman	1.4	In Progress
UNH	M. Leuschner	1.5	Signed
TJNAL	R. Carlini	1.6	Signed~~In Progress~~

3.5 Costs

The total budgeted costs for the construction of the experiment and beamline are presented in Table 3.4. Shown in the first column are the total combined costed (by Feb-2001) DOE equipment and capital labor and LANL institutional funds. In the next columns are shown the total projected funding for DOE equipment and capital labor combined with LANL institutional funds. Next is shown the expected funding from the outside collaborators showing separately the NSF contribution. All figures are in FY01 dollars.

Table 3.4 Summary of NPDGamma costs in FY01 dollars without escalations.

	COSTED	FUTURE				
	DOE/LANL	DOE/LANL		Collaboration		
		Equipment	Capital Labor	Equipment	NSF Capital	Total
Experiment	83	1195	427	313	344	2362
Beamline	687	1209	470	31		2397

In Table 3.5 and 3.6 the funding profile of the LANL institutional funds and DOE equipment and capital labor funds is shown in FY01 dollars for the beamline construction and experiment construction. Also included is the 5% escalation.

Table 3.5 Beamline funding profile only for DOE capital and LANL institutional funds with escalations.

	Prior Years	FY01	FY02	FY03	Total Cost
LANL	482	0	0	0	482
DOE:					
Funding	205	1200	479	0	1884
Escalation (5%)	0	0	24	0	24
~~Total~~Total	687	1200	503	0	2390

Table 3.6 Experiment funding profile only for DOE capital and LANL institutional funds with escalations.

	Prior Years	FY01	FY02	FY03	Total Cost
LANL:					
Funding	0	26	175	217	418
Escallation (5%)			8	22	30
DOE:					
Funding	83	736	372	96	1287
Escalation (5%)			19	10	29
Total	83	762	574	345	1764

More funding details are discussed in Chapter 6. The breakdown of the total costs in WBS level 3 is shown in Appendix A (experiment) and Appendix B (beamline).

3.6 Schedule

Table 3.7 provides the major milestones for the NPDGamma beamline construction and Table 3.8 for experiment construction.

Table 3.7 Major beamline construction milestones.

WBS	Major Milestone	Completion Date
2.1.2.7	Thimble designed	Completed
2.1.4.2.1	Thimble installed	Completed
2.1.2.9	Guide insert&transporter design complete	Completed
2.1.3.21	Thimble, insert, transported fabricated	Completed
2.1.4.9.1	Transporter modifications finished	6/01
2.1.3.20	In-pile guide received	7/01~~Q3, 2001~~
2.1.4.7	In-pile guide installed	1/02~~Q1, 2002~~
2.2.4.1.1	ER1 floor modifications complete	4/01~~Completed~~

2.2.2.5	Shutter design complete	7/01~~Q3, 2001~~
2.2.3.6	Shutter fabrication complete	10/01~~Q4, 2001~~
2.2.4.8	Shutter complete	2/02~~Q1, 2002~~
2.3.2.5	Chopper design complete	7/01~~Q2, 2001~~
2.3.3.11	Chopper fabrication complete	8/01~~Q3, 2001~~
2.3.4.3	Shipping to Los Alamos	1/02~~Q1, 2002~~
2.3.4.8	Chopper installed	3/02~~Q1, 2002~~
2.3.5.2	Chopper commissioned	12/02~~Q4, 2002~~
2.4.1.6	Conceptual design of integrated shielding	6/01~~Q2, 2001~~
2.4.2.4	Integrated shielding design complete	10/01~~Q4, 2001~~
2.4.3.8	Shielding procurement completed	2/02~~Q1, 2002~~
2.4.4.2	Integrated shielding complete	2/02~~Q2, 2002~~
2.5.2.9	Floor and wall penetrations designed	9/01~~Q4, 2001~~
2.5.3.1.5	Guide ordered	4/01~~Completed~~
2.5.3.9	Guide fabrication inspection	1/02~~Q1, 2002~~
2.5.3.1.5	Guide delivered	3/02~~Q2, 2002~~
2.5.3.11	Guide support and penetrations completed	12/01~~Q4, 2001~~
2.5.4.7	Guide installation completed	4/02~~Q2, 2002~~
2.6.2.3	Plans for ER1 modifications complete	9/01~~Q3, 2001~~
2.6.4.3	ER1 modifications complete	12/01~~Q4, 2001~~
2.7	End of Beamline Construction	12/02~~Q4, 2002~~

Table 3.8 Major experiment construction milestones.

WBS	Major Milestone	Completion
1.1.2.1	Test of prototype preamp in beam	Completed
1.1.2.5	Design of preamplifiers complete	7/01~~Q3, 2001~~
1.1.3.5	Preamplifiers procurement complete	2/02~~Q1, 2002~~
1.1.4.5	One signal channel working	8/02~~Q3, 2002~~
1.2.2.2	DAQ first time functioning	Completed
1.2.4.1	1 DAQ station complete	8/01~~Q3, 2001~~
1.2.3.1.3	VME station 2 complete	10/01~~Q3, 2001~~
1.2.3.2.2	VME station 3 complete	1/02~~Q1, 2002~~
1.2.4.4	Working DAQ software	1/02~~Q1, 2002~~
1.2.5.1	DAQ commissioned	12/02~~Q4, 2002~~
1.3.4.10	Submission of IUCF NSF proposal	Completed
1.3.4.11	Submission of IUCF MRI proposal	Completed
1.3.2.2	Design of detector complete	7/01~~Q3, 2001~~
1.3.3~~4~~.4.3~~2~~	10 CsI crystals ordered	7/01~~Q3, 2001~~
1.3.3.5.1	Indiana begins ~~x-tals~~crystal procurement	8/01~~Q3, 2001~~
1.3.3.6.1	Detector procurement complete	7/02~~Q2, 2002~~
1.3.5.2	Detector complete	1/03~~Q3, 2001~~
1.4.1.10	Polarizer conceptual design completed	Completed
1.4.2.12	Design of polarizer completed	2/02~~Q1, 2002~~
1.4.3.2.8	NMR electronics procured	12/01~~Q4, 2001~~
1.4.4.3	First full sized sealed cell with long T_1	6/01~~Q2, 2001~~
1.4.4.5~~3~~.5	Construction and testing of additional sealed cells completed	5/02~~Q2, 2002~~
1.4.4.2	Decision of sealed cell geometry	8/01~~Q3, 2002~~
1.4.4.6	Working group decision for final polarizer	1/02~~Q1, 2002~~
1.4.4.7	Working group decision for laser system	2/02~~Q1, 2002~~
1.4.4.23~~1~~	Polarizer completed	12/02~~Q4, 2002~~
1.5.1.3	Flipper concept complete	Complete
1.5.2.6	Flipper design complete	7/01~~Q3, 2001~~
1.5.4.7	Flipper built	1/02~~Q1, 2002~~
1.6.1.2	Field calculations completed	8/01~~Q3, 2001~~
1.6.2.4	Guide field design complete	1/02~~Q1, 2002~~
1.6.3.9	Guide field procurement complete	6/02~~Q2, 2002~~
1.6.4.7	Guide field complete	11/02~~Q4, 2002~~
1.7.1.4	Review of conceptual target design and safety	Complete
1.7.1.7	LH2 target collaboration meeting	Complete
1.7.2.1.1	Target engineering design complete	6/01~~Q2, 2001~~
1.7.2.7.1	Passed target design safety review	8/01~~Q3, 2001~~
1.7.3.20	Target procurement done	10/02~~Q4, 2002~~
1.7.4.5	Target testing in Indiana completed	8/02~~Q3, 2002~~
1.7.4.15	Target testing complete	5/03~~Q2, 2003~~
1.7.4.15.2	Target installation complete	4/03~~Q2, 2003~~

1.7.5.3	Target complete	6/03~~Q3, 2003~~
1.8.2.1.1.	Monitor #1 design complete	6/01~~Q2, 2001~~
1.8.3.5	Monitor #1 delivered	8/01~~Q3, 2001~~
1.8.4.2.1	Monitor #1 tested	12/01~~Q4, 2001~~
1.8.4.7	Back monitor ready	8/02~~Q3, 2002~~
1.8.5.2	Monitors complete	12/02~~Q4, 2002~~
1.9.1.6	Agree conceptual design of cave shielding	10/01~~Q4, 2001~~
1.9.2.8	Cave design complete	1/02~~Q1, 2002~~
1.9.4.9	ER2 shielding installation started	5/02~~Q2, 2002~~
1.9.4.8	Cave completed	11/02~~Q4, 2002~~
1.10.1.2	Conceptual design of utilities complete	7/01~~Q2, 2001~~
1.10.2.2	Utilities designed	10/01~~Q4, 2001~~
1.10.4.3	Utilities completed	10/02~~Q3, 2002~~
1.11	End of Experiment Construction	6/03~~Q2, 2003~~

The rollup schedule for the NPDGamma is presented in Appendix D.

3.7 Work Breakdown Structure

The NPDGamma project WBS, presented below, provides the basis for the cost account structure and schedule organization. Further details of the level 1 through level 3 WBS elements is provided by the WBS Dictionary included in Appendix C.

Table 3.9 WBS structure for construction of NPDGamma experiment and beamline.

WBS		WBS	
1.0	EXPERIMENT:	2.0	BEAM LINE:
1.1	Signal Electronics	2.1	In-Pile
1.2	Data Processing	2.2	Shutter System
1.3	Detector	2.3	Chopper System
1.4	^{3}He Polarizer	2.4	Integrated Shielding
1.5	Spin Flipper	2.5	Neutron Guide
1.6	Guide Field	2.6	ER-1 Utilities
1.7	LH2 Target		
1.8	Beam Monitors		
1.9	Experimental Cave		
1.10	ER-2 Utilities		

4 WORK PLAN

A Work Package is the basic unit formed around WBS level 2 elements managed by a Work Package Leader. Table 4.1 lists the Work Packages of the construction projects of the experiment and beamline. A Work Package has well defined technical content, specifications, schedule content, and cost content given in Work Package Dictionary in Appendix E.

Table 4.1 Work Package structure.

~~1.0EXPERIMENT~~1.0 EXPERIMENT 1.1 DAQ 1.2 Detector 1.3 Polarizer 1.4 Flipper 1.5 Guide Field 1.6 Target 1.7 Monitors 1.8 Cave 1.9 ER2 Utilities ~~1.1Signal Electronics~~ ~~1.2Data Processing~~ ~~1.3Detector~~ ~~1.4Polarizer~~ ~~1.5Flipper~~ ~~1.6Guide Field~~ ~~1.7Target~~ ~~1.8Monitors~~ ~~1.9Cave~~ ~~1.10ER-2 Utilities~~	2.0 BEAM LINE 2.1 In-Pile 2.2 Shutter 2.3 Chopper 2.4 Integrated Shielding 2.5 Guide 2.6 ER-1 Utilities

~~5~~4 ~~M~~MANAGEMENT OF THE NPDGAMMA PROJECT

5.1 General

In all respects, the construction, installation, testing, and commissioning of the NPDGamma experiment and the beamline must follow the LANL quality assurance guidelines. Additionally, all work has to be conducted in accordance with LANL Integrated Safety Management (ISM) and LANL Safe Work Practices. All the work has to satisfy fully LANL ES&H requirements. The roles of the NPDGamma project management team are explained earlier in this document.

5.2 Management Control
Primary management control is exercised by the Project Manager, who reports to the Spokesperson, whose responsibility is to report to the P-23 Group Leader and the NPP manager. Connection to the collaboration is maintained through regular progress reports and interaction with the Work Package Leaders. Changes to technical aspects, cost, schedule, and performance of the NPDGamma project require appropriate approval depending upon their magnitude as discussed in Section 3.1. The approval levels for change requests are listed in Table 3.1. A Work Package Leader may request a change to cost, schedule, or scope by submitting a written request to the Project Manager who specifies the WBS items involved, the exact nature of the changes, the implications for other Work Packages, and detailed justification.

For foreign collaboration groups, project control is maintained by defining the scope of work to which each group has committed as outlined in their MOUs. To allow the Project Manager to maintain an accurate overview of the status of the project, these groups further agree to follow the guidelines for requests in Table 3.1.

5.3 Technical Control
The Spokesperson and the Project Manager, the Management Team, and Work Package Leaders aided by the collaboration, have responsibility for the technical decisions regarding R&D, engineering, design, fabrication, assembly, testing and installation of all the components. Technical changes with cost, schedule, or performance impact exceeding the levels indicated in Table 3.1 require the indicated approvals.

The NPDGamma Project Manager will monitor the technical progress of the project, evaluating progress against the plan. Whenever technical changes are anticipated or proposed, the Project Manager will evaluate all ramifications. The Project Manager will monitor and evaluate schedule, cost, and interrelated construction and technical work variances to assess programmatic impacts. Should a baseline change be required, the Project Manager will initiate a change action depending on whether the change is technical or cost/schedule related to propose a baseline revision.

Detailed Work Package planning documents are summarized in a Work Package Summary in Appendix E. When approved, the Work Package Summary authorizes the defined work scope to be performed in accordance with the documented technical, budget, and schedule requirements.

Direct responsibility, authority, and accountability for the work is assigned to the Work Package Leaders. All project work is formally authorized at the Work Package level via the Work Package Summary.

The work is authorized at the Work Package level by the approval of the Work Package Summary that defines the technical baseline, the Work Package budget, and the Work Package schedule start and completion dates. Lower level work authorization documents include purchase orders, subcontracts, and similar documents within the management control system.

5.4 Cost and Schedule Control
The basis for cost control is the baseline cost estimates of the NPDGamma experiment and the beamline construction established at WBS Level 3 and shown in this document in level 3. Any changes to the cost of a WBS line item at Level 3 or above must follow the approval requirements indicated in Table 3.1. Cost control at lower WBS levels is the responsibility of the Work Package Leaders, who will report to the Project Manger on a monthly basis. Using the Microsoft Project software, the Project Manager will track the costs. For contingency control, see Section 5.6.

The basis for schedule control is the milestone schedule contained in this document, which represents the best information available to the Work Package Leaders and the Project Management at this time. The Work Package Leaders will track and report their Work Package to WBS Level 4 to the Project Manager, who, using the Microsoft Project software, will track and report down to WBS Level 4. The Project Manager, together with the Work Package Leaders, will update and revise the milestone schedule as needed.

5.5 Performance Control
The basis for performance control is in the table of Change Request Classifications, Table 3.1. This specifies the approval levels required to authorize a change in performance or scope of the experiment or the beam line depending on the expected impact of the change.

To ensure timely identification of potential performance slippage, a progress report will be provided on a monthly basis. The status of the Work Package schedule will be updated at least once per month. The Project Manager is responsible for contingency and overall funds management on the project. Cumulative quarterly data resulting from this process will be used to update the DOE Quarterly Review.

The variance thresholds that would initiate corrective actions are described in Table 5.1.

Table 44~~5~~.1 Variance thresholds.

	Cost Variance	Schedule Variance
Period	25% & $10k	25%
FY	15% & $25k	15%
Cumulative	10% & $50k	10%

The NPDGamma monthly status report will provide an explanation of the corrective action to be taken to address the problem that is causing the variances. This variance reporting and corrective action approach will provide an early warning of potential problems. Prompt recognition and corrective action at this level will help prevent implementation of the change management actions identified in section 3.1.

5.6 Contingency
Contingency funds are included in the NPDGamma project estimate to cover uncertainties and risks. The contingencies have been estimated using Table 6.1. in the lowest WBS level. The

contingency funds are held by the LANL NPP Manager in a separate account. The contingencies are managed by the Project Manager. All the NPDGamma Work Packages that are funded with DOE capital funds shall follow the rules for contingency spending as outlined in the Change Request Classification (Table 3.1).

The use of contingency funds will be monitored closely, and the status of these funds will be reported to key project participants so that the project will not be jeopardized by a cost overrun.

5.7 Progress Reporting

Reporting of the progress of the NPDGamma project to the DOE will be done on a quarterly basis in the form of a NPDGamma Project Quarterly Progress Report. This report will follow the format as set by the Nuclear Physics Division of the Department of Energy. The reports will be compiled and distributed by the Project Manager.

These reports will contain:

1. A narrative report of accomplishments and problems;
2. A milestone schedule and status reports, and;
3. A cost performance report.

In addition, the Project Manager will provide monthly progress reports to the LANL Management, the Executive Committee, and the collaboration.

~~6.0~~6 COSTS

The cost estimates for the project are based on the best information available to the Work Package Leaders at the time this PMP was being written. All estimates are in FY01 dollars. Following the Technical Review of the Spinka II Committee, the collaboration made a new "bottom-up" budget estimate by creating a detailed Work Breakdown Structure for all major components of the experiment and integrated beam line. The WBS and WBS Directory can be found in Appendix C. For each WBS item, detailed task lists were developed to fully define the task. These breakdowns were used to calculate budget estimates and to summarize the resources needed to complete the construction and installation of the NPDGamma experiment and the integrated beam line. The estimates are based in part on existing contracts, in part on budgetary quotes or actual bids, and in part on engineering experience. Also, the NPDGamma estimates have been compared with estimates from similar sized projects such as the SBSS Instrument Construction Projects at LANSCE (SMARTS, PROTEIN, HIPPO, and DANSCE).

Contingency for each item was estimated based on the formulae shown in Table 6.1. These categories were chosen after careful consideration of standard DOE practices for estimating contingency.

Table 6.1 Guidelines used in estimating the contingencies for items in the NPDGamma project budgets.

Contingency Formulae for NPDGamma Budget Estimate		
Category	Description	Amount
Catalog	• Equipment to be purchased through catalog • Fixed price contract (with no rework expected)	5%
Engineered	• Design complete, fully estimated, before bid award • Fixed price contracts (with some rework expected)	15%
Designed	• Design complete, not fully estimated, before bid award • Fixed price contracts (with significant rework possible)	25%
Conceptual	• Design incomplete, concept clear	50%
	• Design incomplete, concept "notional"	>50%

A summary tables of the budget estimates for each work package are shown in Tables 6.2 and 6.3. Table 6.2 shows the overall spending plan of the NPDGamma experiment in FY01 dollars with 5% escalations. Shown is also contingency profile, collaborating institutions funding profile. The last two rows indicate LANL institutional funding and estimated DOE capital funding profiles. Table 6.3 shows the overall spending plan of the NPDGamma beamline construction in FY01 dollars with 5% escalations. Shown is also contingency profile, collaborating institutions funding profile. The last two rows indicate LANL institutional funding and estimated DOE capital funding profiles.

Table 6.2 Summary spending plan for the NPDGamma experiment in FY01 dollars with 5% escalations shown. The last row shows the total estimated DOE capital funding.

WBS	Element	Estimated Cost	Prior Years	FY01	FY02	FY03
1.1	Signal Electronis	39176	0	28194	10982	0
1.2	Data Processing	70240	18625	31363	20252	0
1.3	Detector	589762	37184	502392	39268	10918
1.4	3He Polarizer	242512	0	34732	68100	139680
1.5	Spin Flipper	15597	0	14784	813	0
1.6	Guide Field	46000	0	15000	31000	0
1.7	LH2 Target	314257	27559	141000	79198	66500
1.8	Beam Monitors	25600	0	9200	16400	0
1.9	Cave	536930	0	270664	238734	27532
1.10	ER2 Utilities	72171	0	7434	50304	14433
1.11	Commissioning	21812	0	0	4708	17104
	Total	1974057	83368	1054763	559759	276167
	Contingency	388353	0	171970	178514	37869
	Total estimated cost	2362410	83368	1226733	738273	314036
	Subtract Universities contributions	658060	0	465208	191352	1500

Total	1704350	83368	761525	546921	312536
Escalation (5%)	59381	0	0	27346	32035
Total	1763731	83368	761525	574267	344571
Sub~~s~~tra~~u~~ct LANL institutional funds	448000~~18000~~	0	26000	~~175000~~183000	239000~~217000~~
Total estimated DOE capital funding	1315731~~1345731~~	83368	735525	391267~~399267~~	105571~~127571~~

Table 6.3 Summary spending plan for the NPDGamma beamline in FY01 dollars with 5% escalations shown. The last row shows the total estimated DOE capital funding.

WBS	Element	Estimated Cost	Prior Years	FY01	FY02	FY03
2.1	In-Pile	535670	520073	7532	8065	0
2.2	Shutter	144388	2356	119366	22666	0
2.3	Chopper	118790	64333	45806	8651	0
2.4	Integrated Shielding	465945	66400	179414	220131	0
2.5	Neutron Guide	655838	33809	597468	24561	0
2.6	ER1 Utilities	46799	0	6463	40336	0
2.7	Commissioning	13783	0	0	13783	0
	Total	1981213	686971	956049	338193	0
	Contingency	416148	0	267425	148723	0
	Total estimated cost	2397361	686971	1223474	486916	0
	Subtract Universities contributions	31032	0	23274	7758	0
	Total	2366329	686971	1200200	479158	0
	Escalation (5%)	23958	0	0	23958	0
	Total	2390287	686971	1200200	503116	0
	Subtract LANL institutional funds	0 482000	482000	0	0	
	Total estimated DOE capital funding	0 1908287	204971	1200200	503116	0

Funding of the NPDGamma project is supplied by both domestic and foreign sources. The domestic funds are provided mainly by the DOE and the NSF. DOE funds are awarded through the LANL Nuclear Physics program office. NSF funds are awarded directly to the university collaborators. Table 6.4 shows the financial contributions of the collaborating institutions, the WBS elements for which the funds are used, and the funding agency.

All collaborating groups who have committed funds agree to allocate these funds to their assigned tasks in accordance with the NPDGamma budget presented in this PMP and signed in the MOUs. To allow the Project Manager to maintain an accurate overview of the status of the project, these groups further agree to follow the guidelines for the change requests in Table 3.1. but where the "approval" levels are now considered "reporting" levels.

The foreign contributors have agreed to define the scope of their work through their respective MOUs, and to follow the guidelines in Table 3.1. All these funds have been committed with the understanding that they are contingent upon funding of the grants from their respective agencies and universities.

Table 6.4 Contributions of the collaborating institutions and the funded WBS elements.

Institution	WBS Level	WBS Element	Funds ($k)	Agency
Indiana University	1.3	Detector	354	NSF
Indiana University	1.7	Target	117	NSF
TJNAL	1.6	Guide field	59	DOE
KEK	1.3	Photo diodes	47	Japan
Univ. of Manitoba	1.3&1.8	Detector&Monitors	36	NSERC (Canada)
Univ. of Michigan	1.4	Polarizer	20	NSF
NIST	1.4	Polarizer	19	DOE
Univ. of New Hampshire	2.3	Chopper	31	DOE

Contingency analysis of the combined DOE capital funds and LANL institutional funds in FY01 dollars are shown in Table 6.5 for the experiment and in Table 6.6 for the beamline construction.

Table 6.5 Contingency analysis of the NPDGamma experiment for DOE capital and LANL institutional funds in FY01 dollars.

WBS	Element	Costed & Committed	Total~~Estimat~~ Base~~ed~~ ~~Total~~ Cost	Available Contingency	% of Estimated Total Cost
1.1	Signal Electronics	0	39176	11188	29%
1.2	Data Processing	18625	70240	5412	8%
1.3	Detector	37184	183882	17864	10%
1.4	3He Polarizer	0	203362	32595	16%
1.5	Spin Flipper	0	15597	6880	44%
1.6	Guide Field	-	-	-	-
1.7	LH2 Target	27559	197257	74634	38%
1.8	Beam Monitors	-	-	-	-
1.9	Cave	0	536930	177815	33%
1.10	ER2 Utilities	0	72171	30055	42%
1.11	Commissioning	0	20812	9979	48%
	Totals	83368	1339427	366422	27%

Table 6.6 Contingency analysis of the NPDGamma beamline construction for DOE capital and LANL institutional funds in FY01 dollars.

WBS	Element	Costed & Committed	Total~~Estimat~~ Base~~ed~~ ~~Total~~ Cost	Available Contingency	% of Estimated Total Cost
2.1	In-Pile	520073	535670	46225	9%
2.2	Shutter	2356	144388	59345	41%
2.3	Chopper	64333	87758	10377	12%
2.4	Integrated Shielding	66400	465945	129069	28%
2.5	Neutron Guide	33809	655838	143598	22%
2.6	ER1 Utilities	0	46799	20642	44%
2.7	Commissioning	0	13783	6892	50%
	Totals	686971	1950181	416148	21%

7 SCHEDULE

The schedules for the construction projects of the NPDGamma experiment and beamline were developed using Microsoft Project software and is based on planning information and milestones submitted by the work package leaders. The main constraints on the overall schedule are the running and maintenance periods of the facility and the final funding profile. Summaries of the major milestones for the work package completion, integration, installation , and commissioning were shown in Table 3.7 and 3.8 for the experiment and the beamline, respectively. A Microsoft Project Gantt chart based on the WBS is shown in Appendix